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(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.

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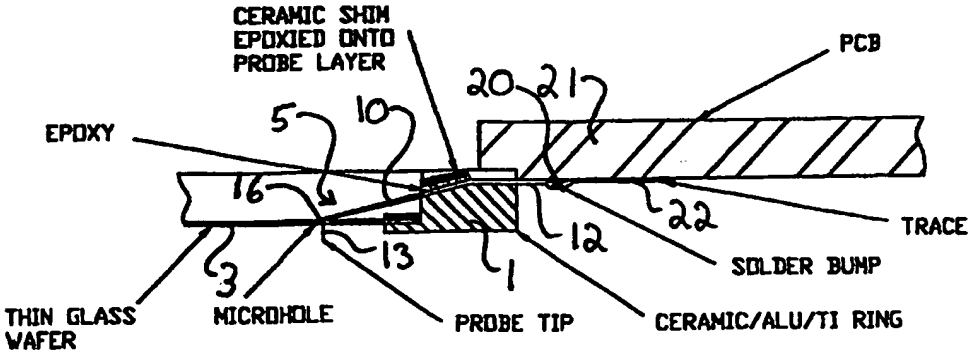
Published:
— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AN INTERFACE DEVICE



(57) Abstract: An interface device (2) provides an interface between testing equipment and an integrated circuit to be tested. The interface device (2) includes a body member (7). A number of elongate contact members (5) are mounted on the body member (7). Each contact member (5) includes a contact end (10), adapted to contact a bond pad of the integrated circuit to be tested, and a body portion (11). The interface device also includes a guide member mounted on the body member (7). The guide member includes a substantially planar member having a number of apertures therein, and the contact end of each elongate member extending through a respective aperture in the guide member.

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AN INTERFACE DEVICE

The invention relates to an interface device for providing an interface between testing equipment and an integrated circuit to be tested using the testing equipment.

A probe card is used in semiconductor wafer fabrication and/or packaging facilities to test the integrity of every semiconductor chip (or die) produced. The process of testing involves testing equipment referred to as "probers" and an interface device that couples the testing equipment to the die to be tested. The interface device is commonly known as a "probe card". The probe card generally comprises a large number of probes, which take the form of pins. The pins are arranged on a printed circuit board, or other supporting structure, in a pattern that corresponds to the layout of the bonding pads on the die to be tested. Each die requires a probe card with a pin pattern that is specific to the layout of the bond pads on the die.

Test signals are exchanged between the prober and the die via the probe card and in particular, the pins that contact the bond pads on the die to be tested. The quality of signals received by the prober from the die is dependent on the quality of the probe card and the quality of contact between the pins and the bond pads on the die.

Conventional probe cards comprise a number of cantilevered probes fixed by epoxy resin to a ceramic or aluminium retaining ring. Typically, the free end of each cantilevered probe (ie the tip which contacts the bond pad) is overhanging the retaining ring by approximately 5mm to 6mm and there is an average pitch (ie spacing between the tips) of between 80µm to 200µm.

However, as chip geometries and resulting bond pad pitches are getting smaller and smaller (currently about 50µm) it is becoming increasingly difficult to design and build probecards using conventional cantilever pin designs.

Therefore, in order to achieve smaller probe pitches, smaller diameter wire is being used to manufacture the probes. However, using thinner wire has the disadvantage that the probes are substantially weaker and the overhanging cantilevered design of the probes makes them susceptible to lateral deflections at the tip. Therefore, the tips can not reliably maintain the correct x-y position. This has the risk that the tip may not contact the correct bond pad on the die during testing, resulting in the prober possibly giving an incorrect test result.

In accordance with a first aspect of the present invention, an interface device for providing an interface between

testing equipment and an integrated circuit to be tested comprises a body member; a number of elongate contact members, each elongate contact member comprising a contact end, adapted to contact a bond pad of an integrated circuit to be tested, and a body portion coupled to the body member; and a guide member mounted on the body member, the guide member comprising a substantially planar member having a number of apertures therein,. the contact end of each elongate member extending through a respective aperture in the guide member, and the width of each contact end being less than the width of the respective aperture to permit lateral movement of each contact end within the respective aperture.

An advantage of the invention is that, as the contact end of each elongate member extends through a respective aperture in the guide member, the guide member limits lateral displacement of the contact ends.

Preferably, the planar member is manufactured from a glass material, such as borosilicate glass.

In accordance with a second aspect of the present invention, an elongate member for an interface device for providing an interface between testing equipment and an integrated circuit to be tested comprises a body portion

and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

Preferably, the tip surface of the contact end is coated with the friction reducing coating.

Typically, the coating may be a hard coating, such as chrome nitride or titanium nitride.

Preferably, the elongate members in the first aspect are the elongate members in accordance with the second aspect of the invention. Typically, where the elongate members in the first aspect are in accordance with the elongate members in the second aspect, the side surfaces of the contact ends are coated with the friction reducing coating. This has the advantage of reducing friction between the side surfaces of the contact ends and the inside surfaces of the apertures in the guide member.

Preferably, the interface device further comprises a printed circuit board to which the ends of the contact members opposite to the contact ends are coupled and the printed circuit board is adapted to permit the testing equipment to be coupled to the printed circuit board.

Preferably, the elongate contact member may be formed from metal wire with a diameter of 1 mil to 10 mil (25μm to 250μm) and is preferably in the region of 2 mil to 10 mil (50μm to 250μm). Typically, the contact surface of the contact ends may have a diameter of approximately 0.5 mil to 5 mils (12.5μm to 125μm) and preferable 1 mil to 2.5 mils (25μm to 62.5μm). The contact surface may be either planar or curved. Preferably, the contact members may be tungsten, beryllium copper, palladium, paliney or an alloy of two or more of these materials.

In accordance with a third aspect of the invention, a method of forming a through bore in a piece of material comprises generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

Preferably, the coherent light is generated be a laser, which may be an excimer laser. Typically, the light

generated by the excimer laser has a wavelength of approximately 193nm.

Typically, the object having the circular cross section may be a spherical object, such as a steel ball. Preferably, the object reflects the light incident on it to minimise heating of the object.

Typically, the through bore to be formed in the piece of material has a diameter less than 100μm and may be from 10μm to 100μm.

Preferably, the apertures in the guide member in the first aspect of the invention are formed using the method in accordance with the third aspect of the invention.

An example of an interface device in accordance with the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic perspective view of a section of an interface device including a guide member;
Figure 2 is a side view of a portion of the interface device; and
Figure 3 is a schematic view of apparatus for forming apertures in the guide member forming part of the

interface device shown in Figures 1 and 2.

Figure 1 shows a schematic view of a portion of a probe card 2. The probe card 2 includes a ring 1 formed from ceramic, aluminium or titanium, a guide member in the form of a glass wafer 3 and a number of contact pins 5 mounted on the ring 1 by means of a ceramic shim 6 and epoxy resin 7.

As shown in more detail in Figure 2, each of the contact pins 5 comprises a central body portion 10 which rests on and is fixed to the ceramic shim 6, a contact end 13 and a PCB end 12 which is electrically coupled by solder 20 to a trace 22 on a printed circuit board (PCB) 21.

The contact pins 5 are typically manufactured from a metal wire such as tungsten, beryllium copper, palladium, paliney alloy or any other suitable metal material. The contact pins 5 can also be comprised of a suitable base metal with another metal coated on this base metal. The wire diameter is typically in the region of 1 mil to 10 mil (25μm to 250μm) and the surface of the contact end 13 may have a diameter of approximately 1 mil to 2.5 mil (25μm to 62.5μm) with a flat or curved surface. In addition, the contact end 13 is etched to form a taper.

The glass wafer 3 is typically a borosilicate glass and has micro holes 16 therein which may be formed by laser drilling, and the contact end 13 protrudes through the micro holes 16.

Preferably, the contact ends 13 of the pins 5 are coated with a hard coating, such as chrome nitride or titanium nitride. This has the advantage of reducing friction between the contact surface or tip of the contact pins and the bond pads on a die being tested, which improves tip life. In addition, if the sides of the contact ends 13 are also coated, this reduces friction between the sides of the contact ends and the inside surfaces of the apertures 16.

Preferably, the laser drilling is performed using an optical arrangement as shown in Figure 3. An excimer laser 30 emits light with a wavelength of 193nm and an energy of 200mJ per pulse. The light beam from the laser is then collimated by collimating optics 31 to form a collimated beam of light with a circular cross-section. A steel ball 32 is fixed to a glass plate 33. The steel ball 32 has a diameter which is less than that of the output beam from the collimating optics. Therefore, when the centre of the collimated beam strikes the center of the steel ball, the central portion of the collimated beam is reflected and scattered from the steel ball but the outermost section of

the collimated beam passes by the steel ball 32 undeviated and passes through the glass plate 33. Hence, the steel ball 32 forms an optical mask, the output beam from which is a collimated annular beam. The collimated annular beam is then focused by focusing optics 34 onto the glass wafer 3 to burn an annular ring in the glass wafer 3 to form an aperture 16.

In order to form an aperture 6, the laser 30 typically operates at a pulse rate of 50 Hz for 20s. However, this will depend on a number of factors such as the thickness of the wafer 3 and the type of glass from which the wafer 3 is formed.

The invention has the advantages that by using the glass wafer 3 as a guide member, the apertures 16 limit lateral displacement of the contact ends 13. This permits thinner diameter wire to be used for the pins 5 which enables higher pitch densities for the pins 5 to be achieved while still maintaining the lateral position of the contact ends.

In addition, as the axis of the apertures 16 is substantially vertical, vertical movement of the contact ends 13 is not affected by the presence of the glass wafer 3.

CLAIMS

1. An interface device for providing an interface between testing equipment and an integrated circuit to be tested, the interface device comprising a body member; a number of elongate contact members, each elongate contact member comprising a contact end, adapted to contact a bond pad of an integrated circuit to be tested, and a body portion coupled to the body member; and a guide member mounted on the body member, the guide member comprising a substantially planar member having a number of apertures therein, the contact end of each elongate member extending through a respective aperture in the guide member, and the width of each contact end being less than the width of the respective aperture to permit lateral movement of each contact end within the respective aperture.

2. An interface device according to claim 1, wherein the elongate contact member is formed from metal wire with a diameter of 1 mil to 10 mil (25μm to 250μm).

3. An interface device according to claim 2, wherein the elongate contact member has a diameter of between 1 mil to 6 mils (25μm to 150μm).

4. An interface device according to any of claims 1 to 3,

wherein the planar member is manufactured from a glass material.

5. An interface device according to claim 4, wherein the glass material is borosilicate glass.

6. An elongate member for an interface device for providing an interface between testing equipment and an integrated circuit to be tested, the elongate member comprising a body portion and a contact end, the contact end adapted to contact a bond pad on an integrated circuit to be tested, and the contact end having a friction reducing coating.

7. An elongate member according to claim 6, wherein the tip surface of the contact ends is coated with the friction reducing coating.

8. An elongate member according to claim 6 or claim 7, wherein the coating is a hard coating.

9. An elongate member according to claim 8, wherein the hard coating is selected from chrome nitride and titanium nitride.

10. An interface device according to any of claims 1 to 5,

wherein the elongate members are in accordance with any of claims 6 to 9.

11. An interface device according to claim 10, wherein the side surfaces of the contact ends are coated with the friction reducing coating.

12. A method of forming a through bore in a piece of material comprising generating a substantially parallel beam of coherent light, illuminating an object having a substantially circular cross section with a diameter less than the diameter of the beam with the substantially parallel beam to form an annular beam, and focusing the annular beam onto the piece of material so that the annular beam incident on the piece of material has an external diameter corresponding to that of the desired through bore to burn away a corresponding annular piece of material to form the through bore.

13. A method according to claim 12, wherein the coherent light is generated be a laser.

14. A method according to claim 13, wherein the laser light is generated by an excimer laser.

15. A method according to claim 14, wherein the light

generated by the excimer laser has a wavelength of approximately 193nm.

16. A method according to any of claims 12 to 15, wherein the through bore to be formed in the piece of material is less than 100μm.

17. An interface device according to any of claims 1 to 5, 10 or 11, wherein the apertures in the guide member are formed using a method in accordance with any of claims 12 to 16.

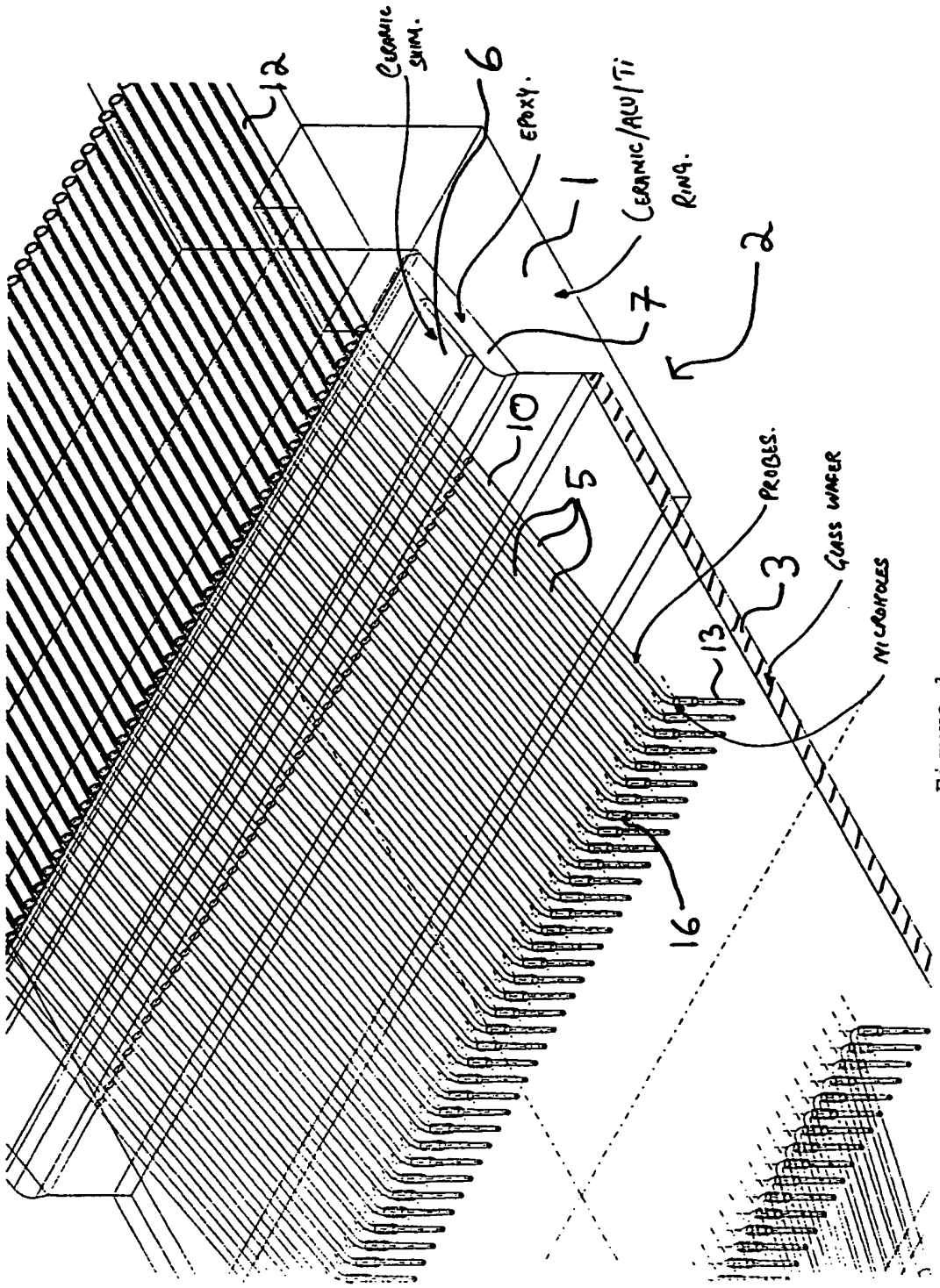
12
Ceramic shim.
6
Epoxy.
1
Ceramic/Alu/Ti Ring.
7
2
10
5
Probes.
Glass wafer
3
13
Microholes
16

Figure 1

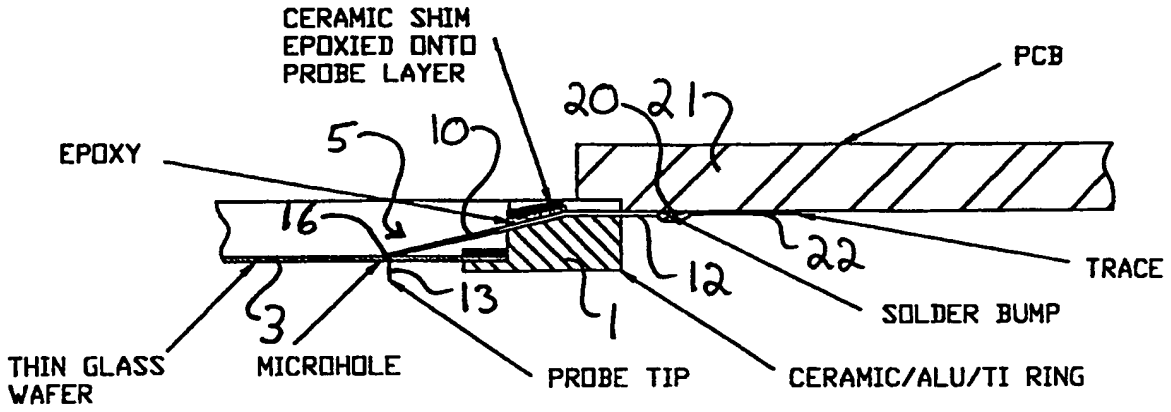

FIGURE 2

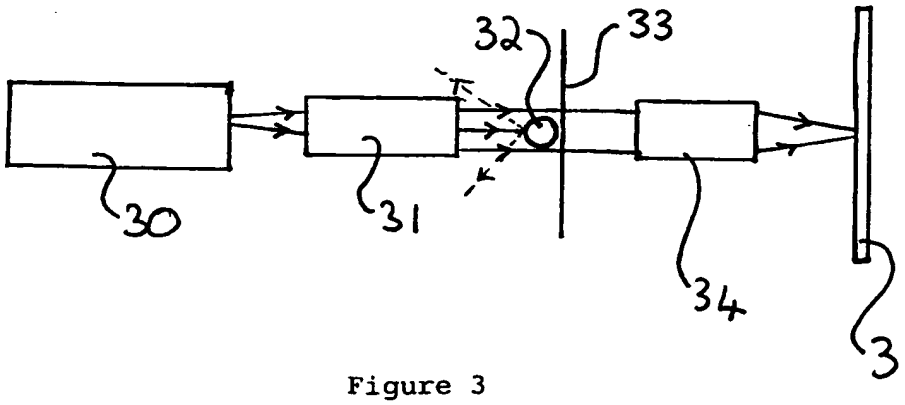

Figure 3

09/980055

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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PCT

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(74) Agent: **MCCALLUM, Graeme, David**; Lloyd Wise, Tanjong Pagar, P.O. Box 636, Singapore 910816 (SG).

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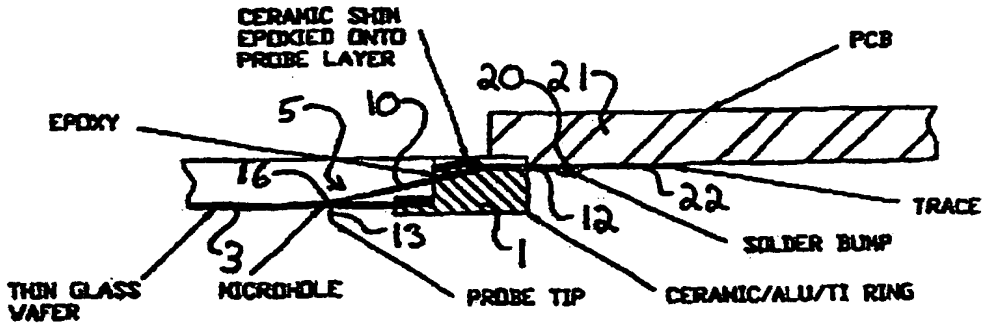
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
11 July 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: AN INTERFACE DEVICE



(57) Abstract: An interface device (2) provides an interface between testing equipment and an integrated circuit to be tested. The interface device (2) includes a body member (7). A number of elongate contact members (5) are mounted on the body member (7). Each contact member (5) includes a contact end (10), adapted to contact a bond pad of the integrated circuit to be tested, and a body portion (11). The interface device also includes a guide member mounted on the body member (7). The guide member includes a substantially planar member having a number of apertures therein, and the contact end of each elongate member extending through a respective aperture in the guide member.

WO 00/074108 A3

F TENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 31 January 2001 (31.01.01)	
International application No. PCT/SG99/00048	**Applicant's or agent's file reference** FP1086
International filing date (day/month/year) 28 May 1999 (28.05.99)	**Priority date** (day/month/year)
Applicant SAWHILL, Robert, Arthur, Jr. et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

22 December 2000 (22.12.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer S. Mafla
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

09/980055
5010

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

12

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
FP1086		
International application No.	International filing date (*day month year*)	Priority Date (*day month year*)
PCT/SG 99/00048	28 May 1999 (28.05.1999)	
International Patent Classification (IPC) or national classification and IPC		
IPC[7]: G01R 1/07, 31/28; H01L 21/66		
Applicant		
Spire Technologies Pte., Ltd. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examination Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I. ☒ Basis of the opinion
- II. ☐ Priority
- III. ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV. ☒ Lack of unity of invention
- V. ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI. ☐ Certain documents cited
- VII. ☐ Certain defects in the international application
- VIII. ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
22 December 2000 (22.12.2000)	19 October 2001 (19.10.2001)
Name and mailing address of the IPEA/AT Austrian Patent Office Kohlmarkt 8-10 A-1014 Vienna Facsimile No. 1/53424/200	Authorized officer MAYER T Telephone No. 1/53424/452

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SG 99/00048

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☐ the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____, filed with the letter of _____.

☐ the claims:
pages _____ , as originally filed
pages _____ , as amended (together with any statement) under Article 19
pages _____ , filed with the demand
pages _____, filed with the letter of _____.

☐ the drawings:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____.

☐ the sequence listing part of the description:
pages _____ , as originally filed
pages _____ , filed with the demand
pages _____ , filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____.

☐ the claims, Nos. _____.

☐ the drawings, sheets/fig _____.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirements of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirements of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☒ not complied with for the following reasons:

Claims 1 to 11 are directed to a probe card for testing integrated circuits wherein the contact members are lead through a guide hole and claims 12 to 17 are directed to a method of forming through bores using focused coherent light.

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this opinion:

- ☐ all parts.
- ☒ the parts relating to claims Nos. 1-11 .

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/SG 99/00048

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement			
Novelty (N)	Claims	6-11	YES
	Claims	1-5	NO
Inventive step (IS)	Claims	8,9	YES
	Claims	1-7,10,11	NO
Industrial applicability (IA)	Claims	1-11	YES
	Claims		NO

Citations and explanations (Rule 70.7)

The following documents are recorded in the Search Report:

D1: EP0262371 A2
D2: JP4145640 A
D3: JP9281139 A
D4: JP11176893 A
D5: US5532613 A
D6: US5754057 A
D7: JP11038044 A

Document D1, which is considered to represent the most relevant state of the art, clearly discloses a probe card for testing the integrity of semiconductor chips comprising a number of contact needles corresponding to the number of contacts of the component to be tested wherein the needles are U-shaped with one arm of each protruding vertically down through a narrow tolerance guide hole in a guide member. The tip of this arm presses on the bonding pad, contacting the device under test.

According to the essential features of present independent claim 1 all relevant details, namely an interface device between testing equipment and integrated circuit comprising a number of elongate contact members (see needles, fig 1, element 3), a body member (see fig 1, element 10) and guide member with apertures (see fig. 1, element 1), have been anticipated in document D1. Therefore no inventive step can be seen. Dependent claims 2 to 5 cannot be considered novel and inventive as well, showing preferred realizations of independent claim1, respectively.

Document D2 explains a testing equipment using a metal needle which is covered with a conductive film such as elastic conductive rubber to be a probe needle. Thus, the surface of a pad to be inspected is not scratched nor dented and the quality of a pattern to be inspected is judged by measuring the conduction resistance by means of electrical connection.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V (page 1)

The combination of all claimed features known from D1 and D2 is obvious. Therefore independent claim 6 cannot be considered inventive as well. Dependent claims 7,10,11 cannot be considered representive an inventive step as well, showing preferred realizations of independent claim 6, respectively.

Documents D3 to D7 show further prior Art probe cards for testing semiconductor devices.

Industrial applicability is given.

Annex to Form PCT/ISA/206

COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International application No.
PCT/SG 99/00048

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:

2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

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DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in a continuation Box.

☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/GB 99/00048

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